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Research Article

Color Stability of Resin-Composites After Staining with a Black Tea

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Abstract

Background: Resin composites are among the tooth-colored restorative materials of choice for many dentists due to their excellent properties. Resin composites are increasingly used by dentists and only a few studies have evaluated the effect of commonly used beverages and medications on discoloration of resin composites.

Objective: The aim of this study was to evaluate color stability of two nanohybrid resin-based composite restorative materials Filtek Z250XT and Herculite XRV following immersion in black tea.

Materials and Methods: Thirty shade B2 cylindrical specimens were prepared from each resin composite according to the manufacturer's instructions using metal molds. Specimens were stored in distilled water for 48 hours at 37°C. The top surfaces of all specimens were wet-polished with silicon carbide papers, and then were randomly divided into two groups of 15 each. All specimens were measured for color values using a spectrophotometer (Testing Phase One-T1). Specimens in each group were immersed in black tea for one hour per day at 37°C for two weeks. Following completion of the immersion time, all specimens were measured for color (Testing Phase Two-T2) similar to testing phase one T1.

Results: The mean (± SD) ΔE values of Filtek Z250XT at baseline before immersion was 1.9 ± 1.1 and for Herculite XRV Ultra **was** 1.1 ± 0.7. There was no significant difference in ΔE* values between the two types of composite resins (P = 0.073). The mean (**±** SD) of ΔE values of Filtek Z250 XT after immersion in black tea was 26.3 ± 0.5 and for Herculite XRV Ultra was 25.1 ± 0.9. A statistically significant change in color for both resin composite materials was evident when comparing between ΔE* values testing phase T2/ Stained and testing phase T1/Baseline (control) (P < 0.01). After being stained, no significant difference in ΔE values was found between both resin composite materials (P > 0.05).

Conclusion: Both tested resin composite restorative materials were susceptible to discoloration by black tea after immersion for 14 hours. There was no difference in the degree of discoloration between the two types of resin composites.

Keywords: *Spectrophotometry; Black Tea; Color Stability; Nanohybrid Resin Composite*

Introduction

Resin composite materials are increasingly utilized in daily clinical practice because of their excellent esthetic properties, mechanical properties, and bonding ability to toothhard tissues [1]. Resin-based composites have been widely used to reconstruct anterior and posterior teeth, as dentistry has progressed [2]. Since the introduction of resin composites, various properties such as inorganic filler technology and monomer chemistry have been continuously advanced to improve the physiochemical features of resin composites [3]. Color stability of resin composites is an important property influencing its clinical longevity, which continues as a challenge inherent to material [2]. Dental esthetic is desired by patients, and the advent of tooth-colored restoratives material has been indispensable for this purpose [1]. Even dentists prefer to use tooth-colored restorative materials, which have different physical properties, and shades compared to non-aesthetic restorative materials such as amalgam [1].

These restorative materials to be clinically successful are required to have long-term continuity, a quality which is strongly influenced not only by the intrinsic characteristics of the materials but also by the environment to which they are exposed [4]. A common problem of color change is encountered with these materials, after months and years of use and exposure to a variety of different food and liquid ingested by patients [1]. In addition, other factors such as low pH due to acidic foods and drinks may influence the material's mechanical and physical characteristics [5].

Intrinsically, color can change due to physiochemical alterations of the resin matrix [6]. Color can also change extrinsically due to the absorption of stains on the outer surface [1]. Many new restorative materials have been developed, and the ability to prevent extrinsic and intrinsic stains of restorations has become an important challenge.

Black tea has received considerable attention in recent years as functional beverages due to the high amount of functional compounds, such as polyphenols, flavonoids, and saponins [7]. Two studies evaluated effect of black tea on color of resin composites reported that black tea caused the greatest color change in all resin composite materials [8,9]. Few studies evaluated effect of black tea on color of resin composites.

Purpose of the Study

The purpose of this *in vitro* study was to evaluate color stability of two nanohybrid resin-based composite restorative materials Filtek Z250XT and Herculite XRV following immersion in black tea. The null hypothesis was no difference in color stability of the two restorative materials exposed to black tea.

Materials and Methods

Thirty shade B2 cylindrical specimens (10 mm diameter, 2 mm thickness) were prepared from two nanohybrid resin-based composite restorative materials Filtek Z250XT (3M ESPE, St. Paul, MN, USA) and Herculite XRV **(**Ultra-Kerr, Brea, CA, USA} according to the manufacturer's instructions using metal molds. In order to obtain a flat polymerized surface without bubble formation, the specimens were covered on both sides (top and bottom) with a polyester matrix strip (Mylar Strip, Henry Schein, Melvilie, NY, USA) and a thin, rigid glass microscope slide (1-mm thick) (Shandon Polysine Slides, Thermo Scientific, Kalamazoo, Mich., USA) and pressure was applied on the slides to extrude the excess material. The restorative materials were polymerized through the glass slide and the matrix strip according to the manufacturer's recommendations, using a light cur unit LED (Elipar free Light 2, 3M ESPE, St Paul, MN, USA) operating in standard mode and emitting not less than 800 mW/cm^2, as measured with a light meter that was placed on the curing unit before beginning the polymerization. Afterward, all specimens were stored in distilled water in a lightproof container for 48 hours at 37°C. The top surfaces of all specimens were serially wet-polished with 800-, 1000-, 1500-, and 2000-grit silicon carbide papers, consecutively and then were randomly divided into two groups/15 each. All specimens were measured for color values according to the CIEL*a*b* color scale using a spectrophotometer (Testing Phase One-T1). The color was measured 3 times in the center of each specimen using a spectrophotometer

(Color-Eye 7000, NY, USA) against a white background using LABCH relative to CIE standard illuminants D65, CWF, and C to measure ΔE* (color difference) for SCI (Specular Component Included).

Specimens in each group were immersed in black tea (Lipton, Unilever Englewood Cliffs, NJ, USA) for one hour per day at 37°C for two weeks [8,9]. The back tea was prepared daily prior immersion period. Following completion of the immersion time, all specimens were measured for color (Testing Phase Two-T2) similar to testing phase one T1. Statistical analyses were performed using the software IBM SPSS Statistics for Macintosh (Version 25 0.0.1, Armonk, NY, USA). Two-way analysis of variance and Tukey's post-hoc analysis were used to tests the interaction between materials and media ($\alpha = 0.05$).

Results

Figure 1 showing the average ΔE for each restorative material before and after the application of black tea. The mean (± SD) ΔE values of Filtek Z250 XT at baseline before immersion was 1.9 ± 1.1 and for Herculite XRV Ultra was 1.1 ± 0.7. There was no significant difference in ΔE* values between the two types of resin composites ($P = 0.073$). The mean (± SD) of ΔE values of Filtek Z250 XT after immersion in black tea was 26.3 ± 0.5 and for Herculite XRV Ultra was 25.1 ± 0.9. A statistically significant change in color for both resin composite materials was evident when comparing between ΔE* values testing phase T2/Stained and testing phase T1/Baseline (control) ($P < 0.01$). After being stained, no significant difference in ΔE* values was found between both resin composite materials ($P > 0.05$).

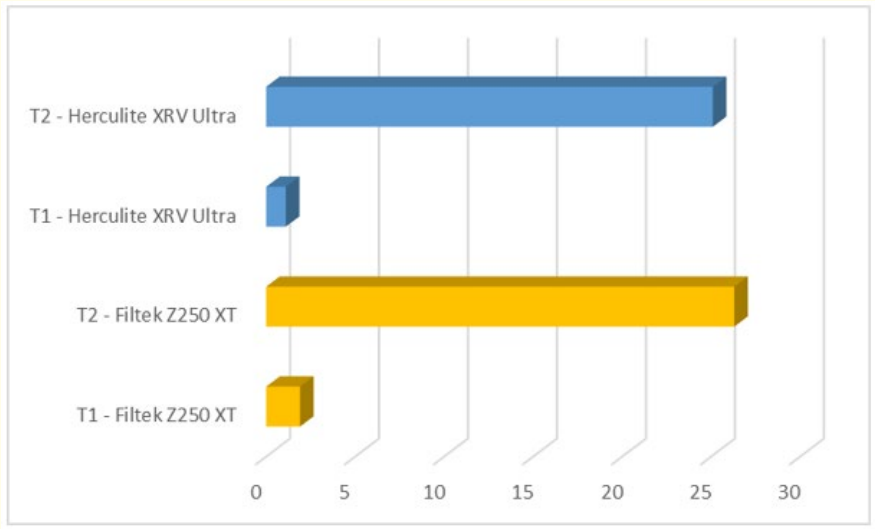

Figure 1: *Showing the average ΔE* for each restorative material before and after the application of black tea.*

Discussion

Color stability of dental restorations is one of the most important characteristics of resin composite materials in terms of longevity [10]. The present study analyzed the colorimetric behavior of two nanohybrid resin-based composite restorative materials to evaluate whether different compositions influence color stability by considering the effect of black tea. The null hypothesis was accepted as there was no difference in color stability of the restorative materials exposed to black tea. Discoloration of restorative materials remains a major cause for their esthetic failure and this can be a reason for the replacement of restorations in esthetic zones. This process concerns both patients and dentists and consumes time and money [11]. The possible discoloration by tea may be due to the adsorption of yellow

colorants onto the surface of the resin composite, which could be removed with tooth brushing [8,9]. The colorant in tea can cause more significant scattering and absorption of light, resulting in reduced translucency [8]. The ingredients of black tea include orange pekoe and pekoe cut black tea.

Discoloration in restorative materials is multifactorial and it can be either intrinsic or extrinsic induced discoloration [12,13]. Resin matrix, filler loading, and photoinitiator systems have a direct impact on intrinsic color stability [14]. Such materials are susceptible to extrinsic staining; including plaque accumulation, superficial degradation, and surface stains due to adsorption of staining agents such as common beverages [15,16].

Color stability can be evaluated both visually and by using specific devices [17,18]. The methodology used in the present study is according to previous studies that used spectrophotometric analysis [17,18]. This system was chosen to evaluate color variation (ΔE*) because it is appropriate for small color changes determination and has advantages such as repeatability, sensitivity, and objectivity [19]. A spectrophotometer is used to measure resistance to staining effects which could be due to tea, coffee and juice and lower values indicate less staining [20]. In the present study, all tested restorative materials were equally susceptible to surface staining which may be related to their composition. Ideally, restorative materials should not change in color or appearance, but a degree of color change can be caused by a number of factors, including incomplete polymerization and water sorption, as well as chemical reactivity.

Consumption of drinks is known to have increased in recent years and the staining of restorations is known to be affected by dietary factors [21]. Few reports were published on the effect of black tea [8,9]. It has been demonstrated that common food and drinks, such as coffee, cola, tea, fruit juices, soy sauce, mustard, and ketchup could cause a significant change in surface color of different restorative materials [22]. It has been reported that the color difference values (ΔE*) ranging from 1 to 3 are perceptible to the naked eye and ΔE* values greater than three are clinically unacceptable [23].

This study had certain limitations, including its *in vitro* setting. *In vitro* studies like this one can fail to reproduce the oral environment, where saliva, oral mastication, antagonist occlusion, and other factors is present that affect the surfaces of restorative materials. In addition, the clinical condition in the mouth is not easy to mimic in the laboratory setting [24]. Thermocycling was not performed in this study to simulate some aspects of the oral environment. Thermocycling should be included in future studies. Another limitation was the use of only two restorative materials. It would have been valuable if more and different restorative materials/systems are tested. It would also be beneficial if the application of black tea on the tested restorative materials for a longer period was evaluated. Furthermore, the restorative material surfaces were flat, which does not simulate a clinical situation. However, in spite of these limitations, the research designates a number of positive links between an *in vitro* effect and a clinical effect.

Conclusions

1. Both tested nanohybrid resin-based composite restorative materials Filtek Z250XT and Herculite XRV restorative materials showed unacceptable discoloration in black tea after immersion for 14 hours.
2. There was no difference in the degree of discoloration between the two types of resin composites.

Conflict of Interest

Authors declare no financial interest or any conflict of interest exists.

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